"Contextualizing the Turbulent Microscale in Global Ocean Processes: Spanning Ten Orders of Magnitude"

Craig Stevens[1,2]
[1]*NIWA Greta Point, Wellington,* [2]*Dept. Physics, University of Auckland, New Zealand*
em:Craig.stevens@niwa.co.nz

The oceans are stratified and often turbulent. Understanding transport of energy and material across and along this stratification is a fundamental and ongoing challenge. Such transport is largely associated with irreversible mixing at the microscale. This impinges of most aspects of ocean science, from understanding diurnal cycling of nutrient availability through to thermal storage at climate scales. We now have 50 years of experience of direct measurement at these scales. Initial instrumentation developed for detection of submarine wakes revealed an ocean subject to a continuum of scales of variability. While the basic approach has evolved little, this belies substantial improvements in noise reduction and the increasing global coverage with reasonably consistent sampling technology. This last point enables improved comparability.

Challenges still remain. Present approaches deal with turbulent anisotropy poorly and the connection between turbulent velocity structure and its influence on diffusivity of material is not well constrained. Beyond these issues is the limit to understanding driven by a paucity of data; such measurements are difficult and time-consuming to collect and not all parts of the oceans are equal. Mixing hotspots around confluences of tide and topography result in a highly heterogeneous energy conversion field. Further to these challenges is the need to evaluate if more in situ data are actually needed, and if so, to get them valued scientifically. The turbulent microscale and stratified finestructure are sub-grid scale in all ocean models. Can models do well enough already? What's left to be learned from direct observation of the smallest scales of motion?

Three threads continue to evolve to provide answers to these challenges. The first is to gather more microstructure data. While ship-based profiling is becoming more and more expensive, autonomous sampling via ocean gliders is the likely future of direct measurement of the microscale. Second, a number of approaches to proxy measurement have been developed for application to CTD (conductivity temperature depth profiler) and Argo float data. These primarily focus on Thorpe Scale and density field strain analyses. Third, continued demonstration of the complexity of the sampled oceans supports the need for direct exploratory observation. In this talk I will review these developments, contextualise with data from field campaigns in extreme environments and discuss future possibilities.